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A STUDY OF THE BLOOD PICTURE OF LAMBS SUFFERING FROM PARASITIC GASTRITIS

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INTRODUCTION

Fourie (1931) investigated the blood changes associated with the experimental infestation of sheep with *Haemonchus contortus*. He concluded that death was due to a post-haemorrhagic anaemia, this conclusion being supported by the presence of material reacting as a blood pigment in the abomasum, and the absence of haemosiderin deposits in the body. This work created the impression that in natural mixed infestations in which *H. contortus* was present the anaemia concomitant with infestation was post-haemorrhagic in type, and an important pathological factor in the disease.

Previous observations by Fraser (1930) did not support this view in that he recorded large depositions of haemosiderin, and on this finding founded the hypothesis of a haemolytic anaemia. Stewart (1933), working with lambs similarly infested, referred to Fourie's work and reported that he had been unable to demonstrate the presence of blood in the abomasum.

In this work the opportunity offered by a natural outbreak of parasitic gastritis was utilised in an endeavour to add to these results, to study blood changes in lambs treated with phenothiazine as compared with those left untreated, and to correlate these findings with changes in weight. The experiment was concerned primarily with blood changes in the lambs and the economic value of phenothiazine as an anthelmintic was not particularly considered.

HISTORY OF THE FLOCK

A flock of 50 lambs, recently purchased, was not thriving. Nine deaths had occurred and the owner had sold four in an emaciated condition. Viscera from a dead lamb were forwarded to the Institute for diagnosis; *Haemonchus contortus* and *Ostertagia circumcincta* were identified and the contents of the large bowel gave a concentration of 25,000 worm eggs per gramme. These findings, in conjunction with the symptoms, led to a diagnosis of parasitic gastritis.

TECHNIQUE

Treatment.—Phenovis liquid (I.C.I., a 56 per cent. weight/volume suspension of phenothiazine in water with a dispersing agent) was administered as a draught at the rate of 0·75 gramme per kilo. live weight.

Egg Counts.—Preliminary egg counts were carried out by the technique described by Taylor (1939). The final count was made by Dr. D. O. Morgan, using the technique given by Gordon and Whitlock (1939).

Haematology.—When leucocytes only were to be examined blood was obtained by pricking a small vein in the ear. For a full blood examination 1 c.c. of blood was taken from the jugular vein. A drop of blood was ejected for a blood smear, and the remainder was discharged into a tube containing 2·5 mg. of a mixture of four parts potassium oxalate and one part sodium fluoride, and was well shaken. Smears were treated with Leishman's stain and 200 cells were classified, but all other measurements were carried out with the oxalated blood. For white and red cell counts blood was diluted with acetic acid or saline by means of Piney pipettes. Viscosity was measured by a Denning Watson tube. Cell volume was estimated by centrifuging blood in small haematocrit tubes for one hour, and recording the mean of two measurements. Haemoglobin was estimated by a Zeiss Ikon haemometer. Fragility was measured by recording maximum haemolysis in sodium chloride solutions varying by 0·05 per cent. Price-Jones curves were made by the method of Hynes and Martin. Special staining for reticulocytes was not considered necessary, since in various species these have been found equivalent to the polychromatic cells together with cells showing punctate basophilia.

The table of normals (*over-leaf*) is given for comparison and to call attention to the wide variation present in apparently healthy sheep when using the above technique. Haemoglobin figures fall within the range of figures recorded for a large number of sheep by other members of the Institute using the more accurate Newcomer disc method of estimation.

Effect of Phenothiazine.—Two lambs were not expected to live and were removed from the flock; the remaining 35 lambs were brought in from pasture on September 12th and folded on cabbages. They were divided into two groups, 18 being treated with phenothiazine on September 12th and again on the 19th and the rest serving as controls.

	Minimum	*Maximum*	*Mode*	*Number of sheep estimated*
Red count (millions)	7·1	17·5	11·0	40
Haematocrit (%) ...	21·0	39·0	30·0	40
Haemoglobin (haemometer)*	11·2	15·0	12·5	25
Viscosity (times water)	4·3	7·8	6·1	18
Fragility (% NaCl) ...	0·45	0·65	0·55	40
White count (thousands)	4·1	17·2	9·0	60
Neutrophiles (%) ...	13·0	60·0	25·0	60
Lymphocytes (%) ...	33·0	84·0	57·0	60
Monocytes (%) ...	0	15·0	2·0	60
Eosinophiles (%) ...	0	21·0	1·0	60
Basophiles (%) ...	0	4·0	0†	60
Mean corpuscular volume (c. μ) ...	19·0	36·0	27·0	40

* Nineteen sheep within the limits of 12 to 13·5 gramme per 100 ml.

† Average 0·3 per cent.

The following indices have been used :—

$$\text{Mean corpuscular volume (c. } \mu) = \frac{\text{Packed cell volume (c.c.) per litre}}{\text{Erythrocyte count in millions per c.mm.}}$$

$$\text{Mean corpuscular haemoglobin } (\gamma\gamma) = \frac{\text{Haemoglobin in grammes per litre}}{\text{Erythrocyte count in millions per c.mm.}}$$

$$\text{Mean corpuscular haemoglobin concentration (per cent.)} = \frac{\text{Haemoglobin grammes per litre}}{\text{Packed cell volume as a percentage}} \times \frac{10}{1}$$

Effect on Intestinal Infestation.—Table No. 1 deals with worm-egg counts and indicates the toxic action of phenothiazine on trichostrongyle worms. Before dosing, the faecal preparations showed a variety of worm-eggs among which those of *Trichuris* sp. and *Strongyloides* sp. were identified. No attempt was made to classify the trichostrongyle eggs, but no *Nematodirus* eggs were apparent. Seven days after the second administration of phenothiazine the eggs of *Strongyloides* sp. only were discovered in the faeces of the treated lambs, but untreated lambs continued to show the original variety of eggs. Sixteen days after the second administration, out of 12 samples from treated lambs four showed no worm-eggs at all, and five others showed eggs of the *Strongyloides* sp. alone, while among the untreated lambs trichostrongyle worms continued to predominate.

Effect on Weight.—The live weight gains of treated and untreated lambs are shown in Table No. 2. During the first three weeks the treated lambs increased in weight more than twice as quickly as the untreated, and at the final weighing, nearly two months after administration of phenothiazine, were still gaining weight more rapidly than the controls. To begin with, the control group had a heavier average weight than that of the treated group. Accordingly, it might be inferred that the folding of the lambs on cabbages by affording better nutrition enabled the more ill-thriven treated lambs to increase towards their normal weight more rapidly than the less abnormal controls. However, the increases in weight shown by individual lambs commencing at identical weights does not support this inference. Examining the figures for the total gain in weight, as given in Table II, by the χ^2 test, according to the following table :—

Gain in Weight	*More than 15 lb.*	*15 lb. or less*	*Total*
Treated lambs ...	14	2	16
Untreated lambs ...	4	12	16
	18	14	32

then $\chi^2 = 12{\cdot}69$, and P = less than 0·001, showing that the result is highly significant.

Table I.—Worm-Egg Counts.

Date	Treated Lambs			Untreated Lambs		
	Number of Samples	Average Count	Remarks	Number of Samples	Average Count	Remarks
12/9/40	10	1,500 e.p.g.	Eggs of various trichostrongyles, of *Strongyloides* sp., and of *Trichuris* sp.	10	1,500 e.p.g.	Eggs of various trichostrongyles, of *Strongyloides* sp., and of *Trichuris* sp.
26/9/40	5	100 e.p.g.	Eggs of *Strongyloides* sp. only	4	3,700 e.p.g.	Eggs of various trichostrongyles, of *Strongyloides* sp., and of *Trichuris* sp.
5/10/40	12	95 e.p.g.	Four samples showed no eggs. Trichostrongyle eggs in three samples. *Strongyloides* sp. eggs made up about 90 per cent. of the total count	8	542 e.p.g.	Trichostrongyle eggs in every sample. *Strongyloides* sp. eggs made up about 22 per cent of the total count.

TABLE II
Weight in pounds

TREATED LAMBS

No.	Sex	12/9	5/10	Gain on Cabbages	2/11	Total Gain
		Lb.	Lb.	Lb.	Lb.	Lb.
1	E.L.	75	85	10	96	21
2	W.	100	106	6	128	28
3	E.L.	85	91	6	103	18
4	W.	93	108	15	126	33
5	E.L.	88	98	10	106	18
6	W.	92	101	9	118	26
7	E.L.	94	102	8	118	24
8	W.	86	104	18	116	30
9	E.L.	89	97	8	116	27
10	E.L.	86	97	11	106	20
11	E.L.	101	110	9	—	—
12	W.	106	116	10	126	20
13	E.L.	94	102	8	112	18
14	W.	104	111	7	124	20
15	E.L.	85	95	10	101	16
16	E.L.	91	100	9	101	10
17	E.L.	100	110	10	—	—
18	E.L.	95	104	9	110	15
Total ...		1,664	1,837	173	1,807	344
Average		92·4	102·1	9·5	112·9	21·5

UNTREATED LAMBS

No.	Sex	12/9	5/10	Gain on Cabbages	2/11	Total Gain
		Lb.	Lb.	Lb.	Lb.	Lb.
19	E.L.	95	108	14	111	17
20	W.	116	118	2	131	15
21	E.L.	95	103	8	111	16
22	E.L.	86	90	4	94	8
23	E.L.	104	103	–1	112	8
24	W.	122	123	1	135	13
25	E.L.	104	104	0	112	8
26	E.L.	91	100	9	110	19
27	E.L.	107	109	2	118	11
28	W.	116	121	5	124	8
29	E.L.	104	110	6	126	22
30	W.	104	111	7	—	—
31	E.L.	102	104	2	116	14
32	W.	115	111	–4	124	9
33	W.	108	104	–4	106	–2
34	E.L.	85	87	2	98	13
35	W.	96	98	2	110	14
Total ...		1,749	1,804	55	1,838	193
Average		102·9	106·1	3·2	114·9	12·1

E.L. = Ewe lamb.
W. = Wether.

Effect on Blood.—The possible effect of phenothiazine on the leucocytic picture is mentioned at the end of the section on leucocytic changes, and the fall in red count after treatment is discussed at the end of the section on anaemic changes and their correlation with weight.

LEUCOCYTIC CHANGES

Fourie claimed little specificity for the leucocytic changes seen in his experimental sheep. He recorded a terminal neutrophile leucocytosis and commented on the absence of eosinophilia. However, in sheep at the stage of recovery there was some increase in the number of eosinophiles. Fraser also noted a relative neutrophilia accompanied in severely infested sheep by an eosinopenia. In slight infestations he found little abnormality except some suggestion of eosinophilia.

Our observations on severely infested sheep sent to the Institute for diagnosis are in accordance with these results, and we have noted little other abnormality.

In this investigation five lambs from the treated group and five from the control group were examined for leucocytic changes. A preliminary examination was made while the lambs were still at pasture and before treatment, counts were made twice a week during the period the lambs were folded on cabbages and a final examination was made on November 2nd, some four weeks after their return to pasture. Unfortunately, present exigencies do not permit the publication of the full tables but the total and differential counts averaged for each group are shown diagrammatically in Fig. 1.

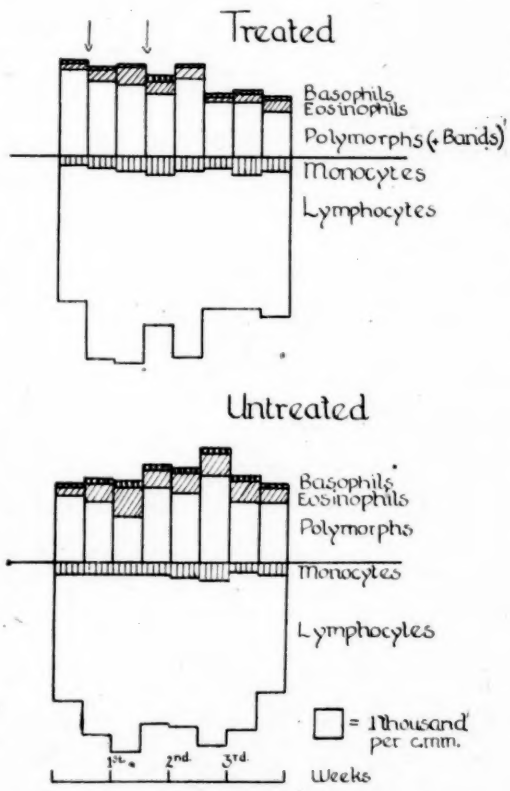

FIG. 1.—Averaged Total and Differential Leucocyte Counts.

At the preliminary bleeding there was little abnormality among the ten selected lambs with the exception of a rather high average for monocytes and the presence of basophiles in nine of the ten films.

During the period the flock was folded on cabbages the following changes were observed. Samples taken four days after being folded on cabbages showed an absolute increase in lymphocytes; this persisted for two weeks in the treated group and for three weeks in the untreated group. In both groups the eosinophiles increased during this period, averaging 4 per cent. in the treated group and 8 per cent. in the untreated group, both figures being double that found in the preliminary examination. Basophiles were frequently present in films from the treated group and always present in the untreated group, where they sometimes averaged 5 per cent. of the differential count. The neutrophiles provided a contrast between the two groups in that the treated group showed a slight progressive decrease throughout the period while the untreated group showed a slight increase that reached its peak on the 18th day and then subsided.

At the final bleeding, after return to pasture, the differential counts were similar to those of the preliminary bleeding.

Two severely affected lambs were not included in the main experiment. They were separated from the flock, housed, given dry food, and one was treated with phenothiazine. Blood samples were taken frequently in order to observe any transient changes in the leucocytic picture following the administration of phenothiazine. On October 3rd both animals had improved in health and were returned to their owner.

Neither showed a neutrophilia at the preliminary bleeding, although the untreated lamb showed a slight neutrophilia on two occasions subsequently, while the treated lamb showed a slight neutrophilia lasting five days after the first administration of phenothiazine, and a shift to the left reaching a proportion of five young and ten band forms out of a total of 40 per cent. neutrophile cells after the second administration of phenothiazine. Both lambs showed an increase in eosinophiles and basophiles after removal from pasture.

In view of the close connection between the presence of parasitic "eosinotactic" substances and a blood eosinophilia, as demonstrated by Weinberg and Seguin (1914-15), it is interesting to note that in this experiment there was no evidence of the presence of such a substance except in lamb No. 23, in which on one occasion the number of eosinophiles reached 27 per cent., and that the reaction of the eosinophiles was similar to that found in inflammatory processes, that is, the presence of an eosinopenia during the acute phase of the disease, followed by a slight eosinophilia during the recovery stage.

Apart from the work of Jorpes (1939) suggesting that the function of basophiles is connected with the production of heparin, little is known of the significance of these cells in the blood. The high level of basophiles present in the untreated lambs is therefore of interest, particularly as Porter (1937) has shown that they also appear in large numbers in another type of worm infestation, namely, the infestation of guinea-pigs with *Metastrongylus elongatus*.

The effect of phenothiazine *per se* on the leucocytic picture would appear to be small, and the increase of lymphocytes, eosinophiles, and monocytes, following its administration seems more readily explained as part of the "recovery phase" of the worm infestation, with a post-infective lymphocytosis, an eosinophilia of recovery, and an increase in monocytic defence. The only changes likely to be associated with the effect of phenothiazine were those shown in the severely affected lamb, in which the first administration was succeeded by a neutrophilia and the second administration by a neutrophilic shift to the left, and the slight progressive decrease in neutrophils occurring in the treated group.

Physical Properties of the Blood and Examination for Anaemia

The five sheep in each group selected for the examination of the leucocytic picture were also utilised for a more complete examination of the blood. Such an examination was carried out on three occasions. A preliminary examination on September 12th, just prior to dosing and segregation on cabbages; a second examination on October 5th, at the termination of the experimental period on cabbages, and a final examination on November 2nd, after the flock had been returned to pasture for four weeks. The details of these examinations are given in Table No. III.

At the first examination, preliminary to treatment, the figures for both haemoglobin and for the red count were low, each with nine out of ten samples below the normal mode. In contrast, the figures for the packed cell volume were within the normal range and were grouped about the mode, thus the figures for the mean corpuscular volume were high and in lambs Nos. 5, 19, 21 and 23 were above the range given by 40 normal sheep.

No abnormality was suggested by the figures obtained for red cell fragility, but viscosity figures were high compared with those estimated for a small number of normal sheep.

Blood smears made at the time these samples were obtained showed little deviation from normal except in the case of one of the severely affected lambs kept indoors. In smears from this lamb an occasional cell showing punctate basophilia was noted, together with anisocytosis, poikilocytosis and polychromasia. The platelets in these films were abnormal in number and morphology. An average of eight was counted in each field of the 1/12th objective, and the morphological abnormalities were similar to those described by Chamberlin (1933) in haemolytic anaemia. These abnormal forms included platelets as large as erythrocytes, and platelets with a "tail" at one or both ends. Round, oval, sausage and triangular forms were also present.

At the second blood examination, at the end of the period during which the flock was folded on cabbages, an unexpected contrast between the two groups was apparent in that, while the red count in the untreated group had risen from an average of 7·9 to one of 9·1 millions, the average for the treated group had fallen from 9·2 to 6·4 millions. During this period regenerative changes were apparent in some smears from three lambs in the treated group and one in the untreated group; two lambs in the treated group showed, in addition, changes in the morphology of platelets, as described by Chamberlin. Red cell fragility remained normal and the viscosity now appeared to correlate with the red blood counts.

TABLE III.

No.	Date	Fragility	Viscosity	Red Cells: Count per c.mm.	Red Cells: Hb grammes per 100 ml.	Red Cells: Haematocrit	Indices: M.C.H. γγ	Indices: M.C.V. c. μ	Indices: M.C.H.C %	Price-Jones Curves: Modal diam. μ	Price-Jones Curves: Av. diam. μ	Price-Jones Curves: Stand. deviat. μ	Price-Jones Curves: Calc. mean av. thick
1	12/9	0·50	7·6	9·2	10·9	25	12·0	27	44	4·5	4·3	0·31	1·8
	2/10	0·50	4·0	7·7	7·9	22	10·2	29	35	4·5	4·8	0·41	1·5
	2/11	0·45	5·5	10·3	8·6	31	8·3	30	28	4·5	4·5	0·26	1·9
2	12/9	0·55	6·8	10·2	10·5	31	10·3	30	34	4·0	3·8	0·37	2·6
	2/10	0·50	3·2	5·0	5·8	15	11·6	30	39	4·5	4·8	0·44	1·7
	2/11	0·50	5·0	9·2	9·0	28	9·8	30	32	4·5	4·6	0·56	1·8
3	12/9	0·45	7·0	11·2	12·8	30	11·4	27	43	4·0	4·2	0·31	1·9
	2/10	0·45	4·1	7·4	11·5	22	15·4	30	52	4·5	4·7	0·43	1·8
	2/11	0·45	5·6	9·4	10·0	28	10·6	30	36	4·5	4·6	0·32	1·8
4	12/9	0·55	6·2	9·4	9·8	31	10·3	33	32	4·5	4·3	0·25	2·8
	2/10	0·55	4·5	5·8	6·0	17	10·3	29	35	4·5	4·4	0·46	1·9
	2/11	0·50	4·7	8·4	6·8	23	8·1	27	30	4·5	4·5	0·40	1·7
5	12/9	0·55	6·5	6·1	10·0	25	16·4	41	40	4·0	4·0	0·42	3·2
	2/10	0·50	3·5	5·9	7·6	18	13·0	30	42	5·0	5·1	0·47	1·5
	2/11	0·55	6·0	8·5	10·4	28	12·2	33	37	4·5	4·6	0·46	2·0
Av.	12/9	0·50	6·8	9·2	10·8	28	11·8	30	39	4·2	4·1	0·33	2·4
	2/10	0·50	3·8	6·4	7·8	19	12·2	30	41	4·6	4·7	0·44	1·7
	2/11	0·50	5·3	9·2	9·0	28	9·8	30	32	4·5	4·5	0·40	1·8
Controls													
19	12/9	0·50	7·0	7·8	9·8	29	12·5	37	32	4·0	4·1	0·30	2·9
	2/10	0·55	4·7	7·6	8·7	23	11·4	30	38	4·5	4·4	0·38	2·0
	2/11	0·55	5·9	9·1	9·6	28	10·5	31	34	4·5	4·4	0·41	2·0
20	12/9	0·50	8·0	9·0	8·0	30	8·9	33	27	4·0	4·1	0·32	2·5
	2/10	0·50	5·8	10·7	9·6	30	9·0	28	32	4·3	4·3	0·17	1·9
	2/11	0·45	5·3	10·4	7·6	30	7·3	29	25	4·0	4·2	0·27	2·1
21	12/9	0·50	7·0	5·8	8·6	25	14·8	43	34	4·0	4·2	0·41	3·1
	2/10	0·50	5·3	9·2	9·2	26	10·0	28	35	4·5	4·6	0·20	1·7
	2/11	0·55	5·9	10·1	8·2	28	8·1	28	29	4·0	4·3	0·43	2·0
22	12/9	0·45	5·1	9·3	8·5	24	9·1	26	35	4·0	4·2	0·38	1·9
	2/10	0·50	5·0	8·6	8·6	24	10·0	28	36	4·5	4·6	0·32	1·7
	2/11	0·50	4·7	9·1	8·2	26	9·0	29	31	4·5	4·4	0·32	1·9
23	12/9	0·55	8·0	7·3	10·4	30	14·3	41	35	4·0	4·0	0·32	3·3
	2/10	0·55	7·0	9·2	8·4	25	9·1	27	34	4·5	4·7	0·36	1·5
	2/11	0·55	4·4	9·5	8·4	25	8·8	26	34	4·5	4·7	0·34	1·5
Av.	12/9	0·50	7·0	7·9	9·1	28	11·5	35	32	4·0	4·1	0·34	2·9
	2/10	0·50	5·5	9·1	8·9	26	9·8	29	34	4·5	4·5	0·28	1·8
	2/11	0·50	5·2	9·7	6·6	27	6·8	28	24	4·3	4·4	0·35	1·9
Bled Sheep													
615	19/11	0·50	7·0	12·0	12·6	32	10·4	27	41	4·5	4·5	0·39	1·7
	21/11	0·50	3·3	6·3	6·8	18	10·6	29	38	4·5	4·4	0·48	1·9
	22/11	0·50	2·6	3·4	3·4	9	10·0	27	38	4·5	4·4	0·64	1·8

At the final blood examination, four weeks after the lambs had returned to pasture, the red counts were still a little low in both groups, but no regenerative changes were apparent in smears. There was again a contrast between the two groups in that the average figures for haemoglobin in the treated group had risen from 7·8 to 9 gramme, while in the untreated group the average had fallen from 8·9 to 6·6 gramme. There were no abnormal figures for viscosity or fragility.

Indices.—It has already been pointed out that at the preliminary examination figures for the mean corpuscular volume in four of the lambs were in excess of the normal range. This increase in volume is to some extent confirmed by the fact that the figures for the mean corpuscular haemoglobin of these lambs were higher than in the remaining lambs. At the second examination, after the period on cabbages, this abnormality in size had disappeared and there was a slight increase in the mean corpuscular haemoglobin concentration. Owing to the wide variation in the figures considered normal for the erythrocyte counts and haemoglobin concentration in sheep, the establishment of a colour index is not considered practicable (Wirth, 1931), but, because the normal erythrocyte is considered to be saturated with haemoglobin, this increase in the M.C.H.C. demonstrated the existence of a previous hypochromic anaemia. Four weeks after the return to pasture the cells remained normocytic, but the average figure for the M.C.H.C. in the treated group had fallen from 41 per cent., at the second examination to 32 per cent., while in the untreated group it had fallen from 34 per cent. to as low as 24 per cent., demonstrating the presence of a marked hypochromic anaemia.

Price-Jones Curves.—The principal data concerning these curves are included in Table No. III, but selected curves are shown in Fig. No. 2. The results from curves made at the preliminary examination were unexpected in that films made from lambs Nos. 5, 19, 21 and 23 (in which the mean corpuscular volume was above normal) did not show a shift to the right, and further, in all ten lambs the mean corpuscular diameter was smaller at this preliminary examination

than at either of the succeeding ones. Any increase in size in the preliminary examination would appear, therefore, to have been due to an increase in thickness, and this has been shown in Table No. III as the calculated mean average thickness.

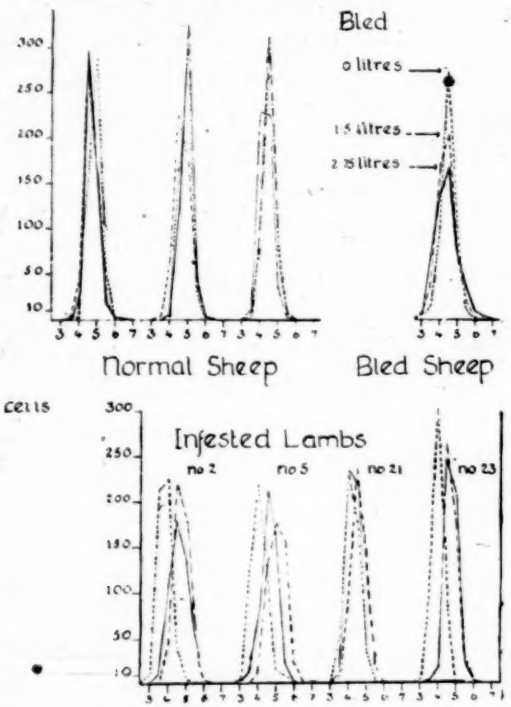

Fig. 2. — Price-Jones Curves for Infested Lambs. Curves for September 12th shown as dotted line, October 2nd as broken line, and November 2nd as a line. Curves for normals constructed for analogous dates.

At the preliminary examination no lamb showed an anisocytosis in any way comparable with that seen in lamb No. 615 suffering from a post-haemorrhagic anaemia (lamb No. 615, Table No. III, and Fig. No. 2). This statement includes the two severely affected lambs despite the fact that in one of these anisocytosis had been recorded among the anaemic changes present in the preliminary blood film. At the second examination, however, the higher figures for standard deviation for all lambs in the treated group suggested some slight anisocytosis in that group. At the final examination the figure for the standard deviation in lamb No. 2 was comparable to that of lamb No. 615, but in the other lambs of the group the figure had fallen.

Anaemic Changes and their Correlation with Weight.—It has been pointed out that after the period during which the lambs were folded on cabbages, the severity of the anaemia in the group treated with phenothiazine had become more pronounced. This increased severity in anaemia appeared to correlate with an increase in weight. This correlation is demonstrated by means of a spot graph in Fig. No. 3.

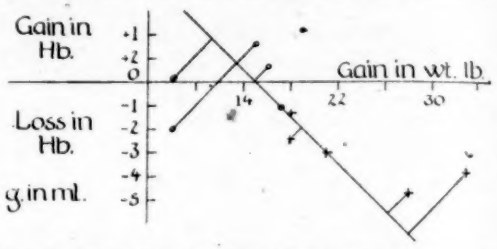

Fig. 3.—Correlation between loss in haemoglobin and gain in weight. + = treated lambs, 0 = untreated. Points are shown tagged to a line given by the equation $2x - y + 15 = 0$, where x represents gain in haemoglobin and y = the gain in weight.

It would thus appear that the presence of parasites interfered with factors concerned with growth, and that when these factors were removed by killing the parasites with phenothiazine, growth was inevitable, even though such growth necessitated an aggravation of the anaemia to a point in which regenerative changes appeared in blood films. This hypothesis is supported by the work of Greig *et al.* (1933) and Innes and Shearer (1940). Greig *et al.* working on "pine" in cattle, concluded that one type was due to an iron deficiency, an assumption supported by the low haemoglobin figures. An iron compound was fed in large quantities, but although nine animals showed a marked improvement in general health, three of the nine showed a fall instead of a rise in the haemoglobin concentration, while in four others the increase was negligible. Innes and Shearer found a most marked hypochromic anaemia combined with an oligocythaemia in pregnant ewes in Derbyshire. The ewes appeared to be in quite good health and the anaemia was suggested as being a physiological adjustment rather than a pathological manifestation. However, whether this phenomenon is regarded as physiological or pathological, it does support the hypothesis that when factors for growth, either of the individual or of the foetus within it, are active, the sheep is prepared to sacrifice its normal haemoglobin concentration in an effort to attain growth.

While the correlation between growth and anaemia is considered to exist in these lambs, and while work supporting the hypothesis that growth can cause anaemia has been quoted, it cannot be denied on our evidence that the growth and the anaemia may both be effects of the administration of phenothiazine. That the action of phenothiazine *per se* does produce an anaemia has been claimed by Errington and Westerfield (1940) following work carried out on horses. Their data, however, do not include figures for live weight increase and hence comparison is impossible.

Discussion of Anaemic Changes

The type of anaemia present in the infested lambs at the preliminary examination was a hypochromia combined with a reduction in red cell count, while in four cases out of ten there was also an excessive mean corpuscular volume. These findings are similar to those reported by Fraser and Fourie, for Fraser reports a chlorosis, but picks out one animal as having a high colour index due to the high proportion of megalocytes, while Fourie reports a hypochromic anaemia with an increase in cell volume, but

includes tables that show that this increase in cell size was not constant.

In spite of the severity of the infestation in our experimental flock the various regenerative changes as reported by Fraser and Fourie were considered to be present in one lamb only, one of the two emaciated lambs kept aside from the main experiment, although in this case the presence of anisocytosis was not confirmed when a Price-Jones curve was drawn. This lamb also showed changes in the morphology of the platelets, as described by Chamberlin (1933). No observations on platelets were made by Fraser or Fourie.

Fourie postulated anaemia as the cause of death in experimental sheep dosed with *Haemonchus contortus* eggs. Our experimental flock was suffering from a severe mixed infestation, 13 animals out of a flock of 50 had died or had been sold in an emaciated condition, and three of the 17 lambs in the untreated group had lost weight during the three weeks they were folded on cabbages, yet despite this the anaemia seemed comparatively unimportant. The blood haemoglobin concentration was higher before treatment than at the final examination made when the lambs were active and thriving, while the lambs that showed most increase in weight did so in spite of the fact that this entailed a considerable increase in anaemia. That the anaemia present at the first examination was to some extent pathological and not entirely dependent on diet, was supported by two observations: firstly, the increase in cell size present at the preliminary examination and absent at the final examination despite the increase in hypochromic anaemia, and, secondly, at the final bleeding the hypochromic anaemia was much more pronounced in the untreated group.

Fourie recorded that the fatal anaemia in his experimental sheep was post-haemorrhagic in type, this conclusion being based on a comparison with a sheep showing a macrocytic hypochromic anaemia induced by repeated bleeding. However, his records show that of the five sheep that received a lethal dose of *H. contortus* eggs only two animals showed an increase in cell size, another showed a decrease and two showed no progressive change. Further, with regard to haemoglobin concentration in the cells, two showed a hypochromia, one showed little change, and the other two showed even an increase in concentration. It would appear likely, therefore, that Fourie was dealing with a variety of anaemias.

Fraser, seeking an hypothesis to explain the marked haemosiderosis present in infested sheep, postulated the presence of an haemolysin that attacked the circulating cells but did not affect the myeloid tissue. Chamberlin (1933) investigated one type of haemolytic anaemia in sheep, namely, enzootic toxaemic jaundice, and showed that the anaemia was not macrocytic but a true anisocytosis with a flattening of the Price-Jones curve. The regenerative changes also included the presence of normoblasts in blood films, in contrast to Fraser's findings that in the case of one infested sheep with a red cell count of only 2·5 millions per c.mm., the only indication of regeneration was the presence of polychromatic cells and an 8 per cent. reticulocyte count. Our own observations on the haemolytic anaemia following the administration of *Cl. welchii* toxin, type A, to sheep (Gordon *et al.*) showed that there was an increase in the fragility of the red cells, and that the clinical signs included haemoglobinuria, phenomena which were absent in cases of worm infestation.

The general blood picture of infested lambs in our investigation was that of hypochromic anaemia, with certain animals showing an increase in red cell size. An alimentary origin for this picture is suggested, based upon the presence of the parasites inhibiting the anabolism of iron to haemoglobin and, in certain cases, interrupting the formation of the haemopoietic principle and thus causing a macrocytic anaemia. A similar macrocytic anaemia is caused in man by the depredations of *Diphyllobothrium latum*, in which case it has been suggested that the worm either prevents absorption of the haemopoietic principle, or consumes it within its own body (Hadfield and Garrod, 1934). In view of this, we consider that in natural worm infestations causing parasitic gastritis the associated anaemia is due to disease of the alimentary tract, and that it is not a definite post-haemorrhagic anaemia. We do not, however, deny that haemorrhage may also be involved to a certain extent. Whitby and Britton (1937), speaking of alimentary types of anaemia, write as follows: "... one single clinical condition may give rise to anaemias which exhibit all possible haematological characters of cell size, cell count, haemoglobin deficiency, and other diagnostic features." In view of the variation shown in the results of Fourie using a pure *H. contortus* infestation, we feel that here, too, anaemia of an alimentary nature may have confused the picture of post-haemorrhagic anaemia.

After the flock had been penned on cabbages for three weeks, affording a different type of nutrition and a freedom from reinfestation, the macrocytic anaemia had disappeared and in most cases the hypochromic anaemia had decreased; these changes occurred in both groups. We have suggested that the anaemia present in the treated group was due to more rapid growth. It consisted of an oligocythaemia showing slight anisocytosis without increase in fragility, and was more normochromic than the anaemia present at the preliminary bleeding. This anaemia was similar to the post-haemorrhagic type, and therefore fits in with the theory that it was induced by growth, but does not so readily support the theory that it was an attribute of the toxic effect of phenothiazine, for such a toxic action would suggest the production of a haemolytic, an aplastic, or even a gastric anaemia.

At the final bleeding, four weeks after the return to pasture, a hypochromic anaemia was again apparent, severe in the untreated group, but less severe in the treated group. This simple hypochromic anaemia, while of little pathological importance in view of the general health of the flock at this time, is of interest in that it existed in a more severe degree in the untreated lambs despite the continued higher growth rate of the treated lambs, suggesting that the conditions ordered by the presence of the parasites still hindered the absorption of iron in the untreated lambs.

Summary

A flock of 35 lambs affected with parasitic gastritis was removed from pasture and folded on cabbages. Eighteen of the lambs were treated with phenothiazine and the remainder kept as controls. Three weeks later the average gain in weight was 9·5 lb. in the treated group and 3·2 lb. in the controls. This

increase in weight was found to be statistically significant. Worm-egg counts were reduced to a greater extent in the treated group.

Preliminary blood samples from ten lambs showed the presence of a hypochromic anaemia, while in four of these cases an increase in red cell volume was apparent. Price-Jones curves were normal but in all cases showed a smaller average mean corpuscular diameter than at subsequent samples, indicating that increased cell volume was dependent on increased cell thickness. Fragility figures were normal while figures for blood viscosity were high. The anaemia is discussed, and it is suggested that it was neither post-haemorrhagic nor haemolytic, but fell within the wide classification of an anaemia of alimentary type. It is further suggested that the presence of anaemia was pathologically unimportant compared with other detrimental factors that inhibited growth.

After treatment with phenothiazine there was a fall in the red count and in the haemoglobin which correlated with the gain in weight—this correlation appeared to agree with the equation $2x + y - 15 = 0$, where x = gain in haemoglobin and y = gain in weight.

Leucocytic changes are recorded, and it is suggested that where an eosinophilia occurred it was connected with the process of recovery and was not due to the liberation of eosinotactic substances by the parasites. The high level of basophiles is commented upon.

Acknowledgments.—We wish to thank Dr. J. R. Greig for his continued helpfulness and encouragement, Dr W. S. Gordon for his help in arranging this experiment, and Dr. D. O. Morgan for advice and for his kindness in carrying out the final worm-egg counts.

The phenothiazine used in this experiment was supplied by the Agricultural Research Council.

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CLINICAL COMMUNICATION

Patent Foramen Ovale and Ductus Arteriosus in a Sealyham

G. V. SHORT, Capt. R.A.V.C.,
Remount Depot, Mona, Punjab

Subject.—A Sealyham dog, aged five months.

Symptoms.—The subject of this case was first brought for advice subsequent to its having had a "fit" after playing. When first seen, cyanosis and dyspnoea were the only obvious symptoms, the respiratory rate being 120 per minute. The possibility of HCN poisoning was eliminated as the cyanosis did not decrease with apparent recovery, the tongue remaining the bluish-purple colour of an indelible lead pencil.

Another "fit" occurred again three days later after the dog had run 20 yards across a lawn. The following notes were made at the time: Collapse and partial asphyxia; respiratory rate 300 per minute; breathing, snoring in character; pulse, 180 per minute and so soft as to be barely perceptible; blood-pressure (femoral artery by Bowmanometer) 77 m.m. Hg.* Blood taken at the time showed an R.B.C. count of 9,855,000 per cubic mm.† Temperature, 97·2° F. Auscultation revealed no murmur, but the valve sounds were faint. Lung sounds normal.

Diagnosis.—Deficiency in auricular or ventricular septum of the heart.

The dog died during a third attack nine days after the second.

Post-mortem Examination.—The findings at *post-mortem* examination were as follows:—

A patent foramen ovale 7 mm. in diameter; a patent ductus arteriosus approximately 4 mm. in diameter. The right ventricular wall was 2·5 cm. thick, and the left ventricular wall was 0·8 c.m. thick.

The aspects which are considered of interest in this case are the abnormally low blood-pressure, and the abnormally high compensatory R.B.C. count. It is surprising that the dog should have lived for five months with this double condition of the heart.

* Dukes—"Physiology of Domestic Animals" (Baillière, Tindall, and Cox, 1937)—gives the average blood-pressure in the carotid artery of a dog under local anaesthesia as 150 mm. Hg. It is not stated what number of tests were made to arrive at this average, nor the ages of the dogs used.

† Mayerson—"Anatomical Record" (Wistar Institute)—gives the average R.B.C. count in dogs as 6,160,000, with extremes (in 60 normal dogs) of 4,800,000 to 8,800,000.

Dogs in hill stations in India at an altitude of 6,000 to 9,000 feet frequently show a count of 8,000,000. The case under review occurred in the plains (altitude 900 feet) and had not recently been in a hill station.

Weekly Wisdom

"*When we say that one ball is three times as big as another, we usually mean that its diameter is three times as long, forgetting, or leaving implied, that its surface is nine times, its cubic content 27 times as big.*—Julian Huxley: "The Individual in the Animal Kingdom."

ANNOTATION

The Healing of Tendons

Both in veterinary and in human medicine the subject of tendon healing has given rise to more discussion than scientific investigation. An editorial article in this journal[1] has summarised the recent discussion on the possible value of "firing." It is concluded that extensive clinical experience has shown that firing is the most serviceable form of treatment in selected cases of sprained tendons in horses, but it is hoped that research will yet establish the true nature of the repair processes in severed tendon tissue. In the same issue, Mr. Hancock has suggested that it would not be difficult to compare the tensile strength of treated and untreated tendons.

Mason and Allen[2] have conducted extensive experiments on these lines, and although their work has little direct bearing on the "firing question," it supplies much fundamental knowledge on the processes of tendon repair and shows that complete rest is not beneficial at all stages.

They divided and sutured the tendons of dogs (chiefly the flexor) and then immobilised the leg for various periods. They studied the process of healing histologically and by tensile strength measurements, and concluded that fundamentally it resembled that of any other tissue, but functional demands influenced the final result. They believe that the connective tissue in and on the tendon, the connective tissue surrounding the tendon and the tendon itself all participate in the process.

During the first four to five days after suturing the tendon ends become oedematous, and at this stage the tensile strength is very low. The connective tissue in, on and about the tendon then proliferates and a cuff is formed about the tendon ends. This process continues until the fourteenth to sixteenth day and is accompanied by a gradual rise in tensile strength. The second stage of healing results in the conversion of this tissue into tendon, and in the opinion of the authors, tendon cell proliferation occurs and the tissue uniting the stumps becomes true tendon in the same way that callus becomes true bone. This stage of organisation is accompanied by a second rise of tensile strength beginning on the nineteenth to twenty-first days, when the cuff of connective tissue begins to separate and eventually becomes true gliding tissue. The tensile strength then does not increase greatly unless the plaster cast in which the limb has been encased is removed, when there is a rapid rise. Actually, after 14 to 16 days, but not before, limited function increases the strength of the union. Active unrestricted use, however, even after three weeks' complete immobilisation, leads to bulbous proliferation, and afterwards to fibrous adhesions between the stumps, sheath and surrounding tissue. It is concluded that there should always be a preliminary period of restricted use.

J. Francis.

[1] *Vet. Rec.* (1941.) **53**. 268.
[2] *Annals of Surgery.* (1940.) **113**. 424-456.

Caithness N.F.U. and Chamber Executive estimate as the result of a survey of some 50 sheep farms with a view to ascertaining losses consequent on last winter's blizzard that there would be 4,000 ewes and 7,000 lambs fewer than in the previous year.

ABSTRACTS

[THE MILK SUPPLY IN TIME OF WAR. Wright, N. C. (1941.) *J. Roy. Agric. Soc., Eng.* **101** (2).]

Fundamental changes have occurred in the dairy industry since the last war, and of these not the least are the creation of the Milk Marketing Board, the imposition of tariffs encouraging the home manufacture of condensed and dried milks and the transfer of butter and cheese production from the farmhouse to the creamery.

A table is given showing the production and utilisation of milk for 1918 and suggestions for a re-allocation are made.

The minimum needs for liquid milk are given, and it is shown that in comparison with the consumption for 1938, a total increase of 40 million gallons was allocated to the liquid market.

Priority is given to the manufacture of condensed and dried milks followed by cheese since other sources of pure fat to replace butter are obtainable, *e.g.*, margarine. The shortage of cheese is stressed; only 140 million gallons have been assigned to home cheese production, sufficient to provide only 1 oz. of cheese per head per week. A table shows the effect of a 12½ per cent. reduction in total supplies. Seasonal reductions are discussed which, although small, necessitate an increase of manufactured products. It is in the amount of milk available for butter manufacture that the most striking fact is seen, and it is shown that only 35 million gallons are available—one-sixth of the pre-war quantity.

The effects of the reduction in supplies of feeding-stuffs are discussed.

The Astor Committee reviewed the milk shortage of 1916-18 and certain factors resembled closely those which confront us to-day. These are discussed together with the tendency in recent years towards increased winter milk production. The bad hay crop may in part have been responsible for the milk shortage in the winter of 1940, but the shortage of labour is causing less trouble than in 1916-18 owing to the greater use of milking machines.

A table comparing pre-war allocations of feeding-stuffs with allowances under war rationing is given. The author points out that the priority accorded to dairy cattle is not without its dangers for there is a grave risk that dairy farmers may assume that such priority absolves them from special effort to produce home feeding-stuffs. It is emphasised, too, that the priority in allocation is based on feeding-stuffs which are available. The diversity of British farming is great and, the rationing scheme being based on average requirements, it seems that some farms will be getting quantities in excess of pre-war requirements, whilst others will have difficulty in getting sufficient supplies.

Dairy farmers must avoid any sense of complacency and every means must be employed to achieve greater self-sufficiency. The author suggests that considerable savings could be affected by improved methods of grassland management with special attention to the value of early and late "bite" as a means of reducing the heavy consumption of feeding-stuffs in April and August, and he maintains that at least half the purchased feeding-stuffs at present used could be saved, equivalent to about 250,000 tons or sufficient to cover the production of over 150 million gallons of milk.

A recent survey carried out by the author shows that by far the best substitute for purchased feeding-stuffs is offered by silage, and this is discussed.

The possibility of a return towards increased summer milk production is considered and graphs are given comparing 1916-18 with 1938 to ascertain what quantitative changes would follow. The figures show that about 250,000 calvings, or about 7 per cent. of the year's total, would have to be altered from the winter to early spring, and this would result in the transfer of about 80 million gallons of milk from winter to summer production with a saving of roughly 125,000 tons of purchased feeding-stuffs.

H. D. L.

* * * * *

[FLUOROSIS IN MAN AND ANIMALS. Discussion. (1941.) *Proc. Roy. Soc. Med.* **34**. 391-400.]

Bosworth mentioned the occurrence of chronic F intoxication in (*a*) volcanic areas of Iceland, (*b*) areas rich in phosphate deposits—*e.g.*, Algeria, Morocco and Tunis—and (*c*) areas around industrial F plants in various parts of the Continent. Possible sources of intoxication included the feeding of mineral deposits rich in F and of lees from distilleries where F compounds are employed. In this country an outbreak occurred in the neighbourhood of brickworks on farms lying in the direction of the prevailing winds. Cattle particularly were affected when grazing and symptoms included unthriftiness, lameness, emaciation, enlargement of the bones of the jaw, metacarpals and digits and exostoses of the ribs. "Mottled" tooth changes resembled those occurring in cattle in the "darmous" areas of North Africa. Apart from cachexia, no lesions other than in the bones and teeth were found. The bones were thicker than normal, with reduced specific gravity. The marrow was reddish and gelatinous and the marrow cavity enlarged. The ribs were very fragile. On maceration the bones showed irregular chalky white porous deposits on the surface and microscopically showed extensive atrophy of the bony tissue and the presence of excessive amounts of osteoid. There was no evidence to show that animals other than cattle were clinically affected, although tooth changes were found in a flock of ewes.

Green discussed the chemical work carried out at Weybridge in association with the above outbreak of chronic fluorosis. High F contents of bone and of urine were characteristic features. F in the blood and milk was very low. The F content of the drinking water was low but that of pasture and hay was high, due to surface contamination and not to absorption through the roots. Atmospheric contamination was demonstrated by absorption methods. The origin of the F lay in the clay used for the bricks, the clay losing one-third of its F at the high temperatures of the kiln. The oily mist containing the F condensed on the surrounding pastures in the direction of the prevailing winds, establishing the complete cycle of events.

Murray discussed the literature of acute and chronic fluorosis in man. Chronic endemic fluorosis is acquired mainly through the water supply owing to the "mottling" of the enamel of the teeth. The pathology of tooth changes was discussed. Some account was given of experimental feeding of F compounds to rats and its effect on bone development.

Bridge referred to cases of human F osteosclerosis arising from monstrial association with F and of certain biochemical findings in this connection, whilst Wilkie discussed X-ray findings associated with these cases.

A. E.

REPORT

[COMMONWEALTH OF AUSTRALIA: COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.—Fourteenth Report (for year ended June 30th, 1940.]

The Council for Scientific and Industrial Research was established in 1926 and its functions include the initiation and carrying out of research in connection with, or for the promotion of, primary and secondary industries; the training of research workers; the making of grants in aid of pure research; the carrying out of scientific investigations connected with standardisation, and the establishment of a bureau of information relating to scientific and technical matters. With the outbreak of war the Council at once considered the steps which it could usefully take to reorientate its investigations with a view to rendering assistance in as direct a way as possible to the war effort of the British Commonwealth of Nations. Careful consideration was given to such problems as what Australian materials could replace those previously imported from overseas; how best Australian materials could be used in new industries; what could be done to reduce the difficulties caused by the damming up of Australian exports and relieve the general upset of normal conditions. The total expenditure of the Council during the financial year under review was £304,933, and of this sum £74,030 was contributed from sources other than the Commonwealth Treasury such as the Australian Wool Board, the Australian Dairy Cattle Research Association, and the Australian Pastoral Research Trust—thus indicating the importance attached to research in matters pertaining to the pastoral industries.

In this review it is impossible to devote adequate attention to Plant Investigations, Entomological Investigations, Soil and Irrigation Settlement Research, Fisheries Investigations, Aeronautics, and Industrial Chemistry except in so far as they have a bearing upon Animal Health and Nutrition with which the *Veterinary Record* is chiefly concerned. Suffice it to say that the most valuable research has been carried out having a most important practical application to present-day problems and the post-war reconstruction of the Dominion. Thus, under the heading "Plant Investigations," we read of the efforts to improve the pastures of many areas of the country by the testing out of grasses from other parts of the world. In Queensland, for example, it was found that *Brachiaria decumbens* and Kenya No. 1 strain of "Rhodes grass" first identified in Rhodesia, were the two outstanding successes. At Canberra—the Australian Capital Territory which is representative of an extensive tract of country that carries a relatively large number of sheep and produces some of the best merino wool in Australia—work was carried out to determine the most suitable methods of management of sown pastures and the improvement of depleted native pastures. Elsewhere attention was given to the control of harmful weeds and chemical and other methods were devised for destroying them. The Division of Economic Entomology also contributed

to these investigations, and it is interesting to note that a beetle introduced some years ago from England to attack St. John's wort produced a devastating effect on that weed. Of greater interest to the veterinarian are the entomologist's investigations in connection with the sheep blow-fly and the influence of attractants and repellants upon it, and particularly the discovery that maggots of *Lucilia cuprina* excrete large quantities of ammonia which increase the susceptibility of a " struck " animal to further oviposition. Under this section of the Report we find also that pure strains of the protozoan parasites and the virus of ephemeral fever have been maintained in Canberra, and supplies of blood containing *Anaplasma centrale* were sent to Queensland for vaccine purposes.

General progress has been made in all branches of the work of the Division of Animal Health and Nutrition. Soon after the declaration of war, officers were called up for military duty, and thus it was not possible to press forward with some of the work, but an attempt was made to concentrate on those aspects which might be calculated to have the more ready application to practical problems in the animal industry. The work of the Division was carried out at the three main centres in Sydney, Melbourne and Adelaide, with field stations at Cunnamulla (Queensland), Badgery's Creek (New South Wales) and Berwick (Victoria), including co-operative work with the State Departments of Agriculture in each State. The secretarial work for the Committee on Animal Production also added appreciably to the Division's responsibilities.

From the Animal Health Research Laboratory, Melbourne, 300,000 doses of pleuro-pneumonia vaccine were issued and until recently gave every satisfaction, but some failures from some quarters are being investigated. Entero-toxaemia of sheep was carefully studied and the view is expressed that " the only treatment which present knowledge suggests is prophylactic vaccination or prophylactic administration of antiserum. The enhancing effect of trypsin upon the epsilon component first described by Bosworth and Glover (1934) has been confirmed." The antigenic analysis of strains of *Cl. novyi* (*Cl. oedematiens*) causing the so-called " black disease " was completed. " Since there is a common ' O ' antigen, it does not appear to be necessary to make anacultures against black disease polyvalent." With regard to caseous lymphangitis, serological studies on strains of ovine and equine origin showed that the ovine strains appeared to have the same antigenic make-up ; while four equine strains differed between themselves and from the ovine strains. Evidence obtained from field experiments on the use of gypsum top-dressing of pastures in the prevention of bovine-haematuria indicated that this procedure delays the onset of the disease up to two years but may not entirely prevent it. Mastitis in dairy cattle was systematically studied in an experimental herd and the results obtained were published in a separate report. Toxaemic jaundice was again shown to be associated with large amounts of copper in the liver and pre-clinical rise of copper in the blood. The attempt was made with some success to develop a complement-fixation test with a view to overcoming the serious handicap arising from the fact that advanced cases of tuberculosis infection no longer react to the tuberculin test ; while the application of a complement-fixation test has proved of value in the elimination of contagious abortion from an experimental herd at Berwick.

The use of monoammonium phosphate in the drinking water has been proved to lower the incidence of a disease known as " peg-leg " or bone-chewing; and winged insects at Townsville were found to be capable of transmitting anaplasmosis.

Parasitological investigations were carried out at the McMaster Animal Health Laboratory, where phenothiazone, diphenylamine, phenoxthin, thionol and phenarsazine chloride were tested as to their anthelmintic properties. None has shown the association of high anthelmintic efficiency and low toxicity characteristic of phenothiazine itself. Comparative tests of the efficacy against trichostrongylosis of phenothiazine, tetrachlorethylene emulsion, and copper sulphate-nicotine sulphate mixture were also carried out, and immunological studies on haemonchosis yielded interesting results.

Parasitological field trials were continued at various centres. These were designed to demonstrate in practice the relative effects of nutrition, management and treatment upon the general health and weight of control and treated animals, and the influence upon the wool production. The influence of atmospheric conditions upon the survival of eggs of larvae of sheep nematodes was also investigated. Elsewhere the sheep-ked was studied with a view to the modification of dipping practice, and the effects of the " Mules " operation and various dressings upon the blowfly were tested. Foot-rot and foot abscess were found to be separate diseases—the former being a contagious infection the causal organism of which is carried over from season to season whereas the latter is non-contagious and troublesome only in abnormally wet seasons.

Biochemical problems in relation to carbon tetrachloride poisoning ; the influence of feed constituents upon trichostrongylosis ; the effect of vitamin B_1 deficiency on pregnancy toxaemia ; chemical studies of wool and, what is known as wool biology, were carefully studied. Fertility in sheep, inheritance of colour and wrinkling, and a genetic study of the Jersey breed of cattle in Australia also received special consideration. Indeed, so much valuable research was carried out in so many problems affecting the pastoral industry in all its branches, that it is quite impossible in a review of this length to deal adequately with any one of them. It behoves every veterinarian interested in the science and practice of his profession, and especially those engaged in research, to endeavour to obtain a copy of the Report from the Government Printer, Canberra, from whom it can be purchased for the sum of 4s. 3d.

It is difficult to determine from the statement of expenditure at the end of the Report the actual cost of the research upon purely animal problems, but exclusive of salaries and contingencies, it appears to amount to approximately £67,000, of which £20,000 was contributed by Pastoral Associations, Trusts and Boards. In this connection it may be interesting to recall that for the year 1936-37 (the last figures available to the reviewer) the agricultural products of Australia were valued at £91,200,000, the pastoral products at £109,300,000, and dairying £46,300,000 ; while in the same year the value of pastoral products exported was (computed in Australian currency) : butter, £7,716,000 ; meat, £10,323,000 ; milk and cream, £852,000 ; hides and skins, £7,809,000 ; wool, £62,529,000 ; and tallow, £811,000. The

(*Concluded at foot of next column.*)

NOTES AND NEWS

The Editor will be glad to receive items of professional interest for inclusion in these columns.

Diary of Events

Sept. 12th.—**59th Annual General Meeting of the National Veterinary Medical Association of Great Britain and Ireland**, in the Connaught Rooms, Great Queen Street, Kingsway, W.C.2, at 2.30 p.m.

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PERSONAL

Birth.—On August 6th, to Muriel, wife of John Sprent, M.R.C.V.S., a son.

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Colonial Service Appointments.—Mr. R. W. Ford, M.R.C.V.S., has been appointed as Veterinary Officer, Gold Coast; and Mr. T. T. Threlkeld, M.R.C.V.S., as Veterinary Officer, Jamaica.

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R.C.V.S. OBITUARY

Brown, William, Capt., late R.A.V.C., 187, Fitzharris Avenue, Bournemouth. Graduated Edinburgh May 23rd, 1894; died August 9th, 1941; aged 69 years.

Hey, Clarence, M.B., C.M., M.R.C.V.S., B.V.Sc. (Liv.), 84, Harley Street, W.1. Graduated Edinburgh December 20th, 1893; died August 11th, 1941; aged 70 years.

Rowlands, R. S., M.R.C.V.S., The Laurels, Pensarn, Abergele. Graduated New Edinburgh May 24th, 1897. Died August 7th, 1941; aged 71 years.

. . . . .

The Late Mr. R. S. Rowlands, M.R.C.V.S.

It was a shock to his many friends to learn that, after a comparatively short illness, Mr. Rowlands had passed away on August 7th. He had graduated at the New Edinburgh College in 1897 and had since practised in the Abergele district. His high professional ability, upright character and genial disposition gained for him an extensive practice as well as a host of friends by whom he will be sorely missed.

He was an ardent Welshman with a wide knowledge of Welsh literature, history and folk lore, and often lectured to various Welsh societies. He was also a keen naturalist and contributed several original articles on the flora of North Wales.

The son of a Methodist minister, he always upheld the principles of a true Christian, serving as a deacon and Sunday School teacher for many years. Of him it can be truly said that he was one of Nature's gentlemen.

He is survived by his widow and two sons—Mr. W. T. Rowlands, who is Veterinary Investigation Officer at Bangor, and Dr. W. T. Rowlands, of the National Institute for Medical Research, Hampstead, for whom much sympathy is felt.

There was a large attendance at the funeral service on August 11th at the Welsh Methodist Chapel, Abergele, when the following members of the profession were present: Mr. K. Ollerhead, London (nephew), and, representing the North Wales Division: Mr. H. L. Jones (President), Capt. J. D. Broome, Messrs. R. L. Lewis, F. Booth and C. W. Cartwright.

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UNIVERSITY OF LONDON EXAMINATIONS IN VETERINARY SCIENCE

The following are among the pass lists issued by the University of London in connection with the July, 1941, examinations for internal and external students:—

Second Examination in Veterinary Science.—Groves, Thomas Wilson; Hawkins, John Derek; Linzell, James Lincoln; Nandi Sambhunath, and Roper, Richard Anthony (all of the Royal Veterinary College).

B.Sc. (Veterinary Science) Examination.—Blair-Fish, Peter Richard; *Macgregor, Douglas Esdaile; Markham, Antony Edward Graham, and Smith, Herbert Williams (all of the Royal Veterinary College).

**External student.*

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MILK RECORDING: NO WITHDRAWAL OF SUSPENSION OF OFFICIAL SCHEME

In a letter replying to Cambridge and District Milk Recording Society, the Ministry of Agriculture has intimated that suspension of the official scheme and financial assistance cannot be lifted. The letter is as follows:—

"I am to say that it was only with great regret and after all the relevant considerations had been taken into account that it was decided to suspend the official Milk Recording Scheme as being one of a number of activities which, however desirable in themselves, could not be regarded as essential to maintain in a time of emergency.

"Careful consideration has been given to numerous representations urging a resumption of the scheme, but the Minister regrets that he does not see his way to withdraw the suspension or to offer any financial assistance to those societies which are operating in the emergency scheme of the Central Council of Milk Recording Societies.

"It is also regretted that, owing to the many additional duties devolving upon Livestock Officers in the present circumstances, it is impracticable to make their services available for the supervision of milk records taken under the emergency scheme."

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"SURGICAL ANTISEPTICS TO AVOID"

A useful addendum to the article on economy in the use of spirit, by G. H. Wooldridge, in our issue of July 12th, is furnished by the following extract from an editorial published under the above heading in *The British Medical Journal* of May 24th: "The war brings with it fluctuating difficulties in the supply of various materials used in everyday medical practice, and some of these, also, are urgently needed in the armament industry. Glycerin is an obvious example, and, in common with iodine, was recently advocated in these columns for the treatment of wounds sustained in air raids. If there are other applications equally efficacious—as indeed there are—they should be used in preference to any that contains glycerin. Another substance we would urge practitioners to use sparingly is alcohol, whether in the form of surgical spirit or of medicinal tinctures. The use of surgical spirit is a familiar ritual, but it may be recalled that Colebrook showed that dettol applied to the skin is remarkably effective in killing surface bacteria. In the whole field of surgical antisepsis the practitioner should ask himself what other antiseptic would do just as well as spirit, and use it."

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expenditure on research, therefore, may be regarded as a form of insurance. It is clear that the Australian Governments and Pastoralists attach the greatest importance to veterinary research and are determined to place their pastoral industries upon a sound foundation, that is, a foundation of good health. Would that the Government and people of this country would follow their example. L. E. W. B.

H.M. STATIONERY OFFICE PUBLICATIONS

The undermentioned have been published recently. Copies can be purchased through any bookseller, or directly from H.M. Stationery Office, at Hotel Lindum, St. Anne's, Lytham St. Anne's, Lancs.

	Price net s. d.	Post free s. d.
EDUCATION, BOARD OF (WELSH DEPARTMENT):		
Circular 1560. War Damage to Educational Property. July 26th, 1941. (28-9999)	0 1	0 2
SCIENTIFIC AND INDUSTRIAL RESEARCH, DEPARTMENT OF:		
Water Pollution Research Board. Summary of Current Literature, Vol. XIV, No. 1. January, 1941. Abstracts Nos. 1-145. (47-81-1-41)	2 0	2 1
WAR OFFICE:		
Treatment of Malaria occurring in Individuals returning from Service in Malarious Areas, Notes on. June, 1941. (57-9999)	0 1	0 2
COMMAND PAPERS (Session 1940-41):		
6298. Colonial Development Advisory Committee. 11th and Final Report covering the period April 1st, 1939—July 17th, 1940	0 3	0 4

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SILAGE FOR POULTRY

The large quantities of lawn clippings which have been left each year to rot into manure for the garden, can be put to better use in time of war. Admirable silage results if these are treated correctly, and the following points, from a paper recently issued by Mr. J. A. George, Cardiganshire County Poultry Instructor, should be useful to those people intending to supplement the rations in this way (states *The Farmers' Weekly*):—

For the small poultry-keeper an air-tight barrel is admirably suited for ensiling young succulent grass.

To conserve coarse grass it is wise to chaff in order to consolidate by tramping and to exclude air, and thus prevent it becoming mouldy.

In order to make a success of the addition of treacle meal at least 3 lb. per cwt. should be used, and sprinkled evenly over the grass three inches deep. Only one pint per cwt. of molasses is required.

Young succulent grass should not be ensiled immediately it has been cut, but left to wilt for three hours in the sun, and then ensiled in the ordinary way.

Waste is generally experienced between collections of grass and has to be thrown away as it is mouldy. Care should therefore be taken to cover the silage, either with a lid that fits tightly into the silo and is weighted down, or with a thickness of coarse grass or hay and weighted down with stones or bricks.

Before adding any additional fodder into the silo, the temperature should rise to somewhere between 100 and 115° F.

To ensure the minimum loss the top of the silo should be covered with sacking and at least 4 in. of earth in a dome shape.

The grass must not exceed 2½ in. in length before cutting or it will be too fibrous for chickens to digest.

Let the clippings dry, either in the sun for about three hours or in an oven.

Mr. George found after some experiment, that silage made along these lines gave an analysis as follows:—

Protein	24·10
Fibre	18·80
Carbohydrates	41·60
Lime	2·39
Phosphate	·86
Other extract	5·34

This analysis shows that sufficient protein content can be obtained and not too much fibre to make such silage a valuable ingredient in the rations. This was fed at the rate of 14 oz., with 10 oz. of household scraps and 21 oz. of mash, to twelve laying hens with very satisfactory results.

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DRUGS FROM HERBS: SAFEGUARDING WAR-TIME REQUIREMENTS

An expert committee recently appointed by Mr. Ernest Brown, the Minister of Health, to review present and future requirements of vegetable drugs and to consider steps to organise the cultivation and collection of medicinal herbs, has presented an interim report containing recommendations.

The committee considers that production in the United Kingdom should be concentrated on the following drugs: Agar, dill, belladonna (leaf and root), Irish moss, colchicum, digitalis, ergot, male fern, liquorice root, hyoscyamus, peppermint, psyllium, sphagnum moss, stramonium, dandelion root, and valerian.

The report states that arrangements have been made by the Ministry for regular growers in the United Kingdom to extend areas under cultivation of certain extremely important drugs which, with other steps taken to secure supplies, epsures that the war- time requirements of these are safeguarded.

The committee points out that while the development of organised collections of wild herbs is most valuable and should be encouraged, the growing of medicinal herbs is a highly specialised industry which is not without its dangers to the inexperienced, and that, therefore, growing by amateurs is to be discouraged.

Further steps are being taken to encourage the methodical collection, proper drying, and marketing of drugs growing wild in the United Kingdom. Collection of the common stinging nettle, dandelion roots, colchicum, and foxglove made by Boy Scout and Girl Guide organisations will be purchased by the trade. The Royal Botanic Gardens, Kew, have arranged with the National Federation of Women's Institutes to organise the collection of 30 essential or important herbs. Explanatory lectures are being organised at the federation's centres in each county.

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OVULATION IN CATTLE

"The acceptance of artificial insemination as a good cattle practice makes it increasingly important to be able to determine the optimum time for mating, in order that the highest breeding efficiency can be attained," states *The North American Veterinarian*, for May, 1941, and proceeds: "Since it is recognised that the life of the spermatozoa in the female reproductive tract is comparatively short, accurate placing of the time of ovulation and insemination at that time should greatly increase the number of pregnancies resulting from one service.

"Brewster and Cole,* who have made observations at 73 oestrual periods of 47 cows of dairy and beef types, furnish us with the most recent information available on this question. In their studies, the end of the oestrual period was determined, following which, at two-hour intervals, observations were made by rectal palpation for ovulation. Nine cows were also examined *post-mortem*, and these findings confirmed previously recorded ovulations.

"In all except three instances, ovulation occurred within the first day after the end of oestrum. The average time for 53 ovulations was 13·57±0·68 hours after the heat period had ended, and 67 per cent. of the ovulations occurred between 8 and 16 hours.

The average time for ovulation in dairy cattle (15±2·6 hours) was close enough to that for beef cattle to suggest no breed variation in the time of ovulation (Angus

* BREWSTER, J. E., & COLE, C. L.: The time of ovulation in cattle. *J. Dairy Sci.* **24**. (1941.) 111-115.

13·93±1·68 hours and Herefords 13·5±0·87 hours). However, the ovulation time for the Shorthorns observed was 12·69±1·15 hours. This difference of 2·31 hours between dairy breeds and Shorthorns may indicate a breed variation, but the number observed was too few to be significant.

"In these observations, both the right and left ovaries produced follicles with equal frequency.

"The greatest variation in time of ovulation was observed between cows that had calved and heifers that had not calved. Sixteen ovulations, observed in yearling and two-year-old heifers, had an average time, following the end of oestrum, of 11·4±0·99 hours, while the average time, in a group of 37 cows from 3 to 12 years of age, was 14·48±0.80 hours."

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HOME FOOD PRODUCTION

An article by Karl Brandt,[1] formerly Professor of Agricultural Economics at Berlin University, has re-emphasised the need for exploiting to the utmost every means of producing food in this country. He shows how the Nazis are using their control of food in the occupied countries as a "beautiful means of disciplining the masses." He considers that the most satisfactory food situation prevails within the boundaries of "Greater Germany" itself, and unless there is a general crop failure in Europe, it is in Britain, owing to shipping losses, that there is the greatest danger of food shortage.

In *The Veterinary Record* (June 7th, p. 33) various means of increasing home food production, including the partial replacement of dietary protein by urea, were discussed. It is, therefore, pleasing to see that Owen, Smith and Wright[2] have confirmed previous work in the value of urea for this purpose provided it is fed in proper amounts and suitable mixtures. It was readily eaten by bovines and produced no ill-effect on their health or milk production.

An apparently valuable means of providing food for direct human consumption has been described by Professor Hardy.[3] Zooplankton is reported to have a nutritive value equivalent to the best meat and phyto-plankton to rye flour—again the investigations have been carried out in Germany. These minute floating creatures are particularly abundant in the coastal waters of West Scotland, an area remote from enemy attack. It is believed that 20 men could improvise enough "filter nets," which swing with the tide, to produce 26½ tons *dry weight* of plankton per day. This subject has been raised in Parliament, together with the possibility of using modern mechanical separators to obtain plankton from sea water.

J. F.

[1] *Readers Digest*, June, 1941. p. 65.
[2] *Nature*. 1941. **147**. 710. (June 7th.)
[3] *Ibid*. 1941. **147**. 695. (June 7th.)

CORRESPONDENCE

Letters to the Editor should reach the Office not later than by the first post on Tuesday morning for insertion in following Saturday's issue.

The views expressed in letters addressed to the Editor represent the personal view of the writer only and must not be taken as expressing the opinion or having received the approval of the N.V.M.A.

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SPASM OF THE DIAPHRAGM IN DOMESTIC ANIMALS

To the Editor of the Veterinary Record

Sir,—An abstract concerning the above condition, appearing in *The Veterinary Record* of August 9th, 1941, contained the following statement: "It consists of pulsation-like beats of the body wall along the line of attachment of the diaphragm and it keeps time with the pulse, simultaneously or immediately after." I assume that this means there will be 60 diaphragmatic spasms per minute when the pulse rate is 60 per minute.

In the horse, at any rate, that has not been my experience. I have seen at least 50 or 60 cases in the horse, and I do not remember one in which the pulse rate and the number of spasms of the diaphragm per minute were the same. In some instances the pulse rate has been the faster, and in others the reverse has been the case.

When spasm of the diaphragm is referred to in the literature, the word hiccough sometimes creeps in. That does not apply to the abstract under discussion, but the term should not be used in connection with horses. It is not a matter of importance to people who have seen the condition, but it is so to many students who have not seen it, for they often jump to the conclusion that the noise occurs in the throat instead of the region of the diaphragm. I have been told of cases in cattle in which some noise appeared to occur in the throat, but in the few cases I have seen in bovines, the symptoms have resembled those seen in horses, although they have been milder in character. In dogs the symptoms have resembled those seen in man.

Yours faithfully,
S. J. Motton.

Penzance.
August 11*th*, 1941.

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THE PRICE OF MILK AND ENCROACHERS

To the Editor of the Veterinary Record

Sir,—Mr. W. A. Campbell wonders why the price of milk has gone up 1,000 per cent. to the consumer. It is rather difficult to estimate how he arrives at the 1,000 per cent. Anybody who has had experience of years of practice among dairy cattle, as Mr. Campbell has, will have noticed what improvements, all to the good, have gradually been made in the housing, cleanliness and tending of dairy cows in recent years and how many shippons have been modernised and altered almost beyond recognition both in internal planning and outside construction—"tell it not in Gath" who has paid for the improvements! We know, too, that the wages of the peasant workers have risen to a modest competence commensurate perhaps to the lower scale of most manual workers. All this has needed money, so naturally the price of milk has gone up.

It is a matter of good book-keeping and accountancy to ascertain and allocate what should be fair profits to the producer and the distributor and also give the farmer sufficient to pay his workers standard wages. It should not be beyond the wit of man to parcel out and estimate fair prices to all those concerned in the production and distribution of milk. I quite agree with Mr. Campbell's reference to the beautiful prospect meted out to panel B men—I had experience of this myself. But, of course, in a matter of *ethics* there are encroachers of varying degree.

Yours faithfully,
G. Mayall.

24, Pool Street,
Bolton.
August 19*th*, 1941.

The Home Secretary has appointed Sir Robert Kelly to be a member of the Advisory Committee on the administration of the Cruelty to Animals Act, 1876, in place of the late Sir D'Arcy Power.

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The Colonial Office announces that the address of the Adviser on Agriculture, the Adviser on Veterinary Services and Secretary of the Colonial Advisory Council of Agriculture and Animal Health, is now as follows: No. 2, Park Street, London, W.1. Telephone No.: Mayfair 8166.